

Seismic Analysis of Buried Reinforced Concrete Tunnels

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ABSTRACT

At the Savannah River Site (SRS) and the rest of the DOE Complex there are many examples of buried tunnels – e.g. large diameter piping and ventilation tunnels. Other than the static soil pressure, the tunnels may also need to withstand loads from seismic events. Buried tunnels are subject to three principal types of deformations when subject to seismic waves: 1) axial, 2) curvature, and 3) ovaling or racking. Axial and curvature deformations result principally in stresses along the length of the tunnel (longitudinal) direction. Ovaling (in circular tunnels), or racking (in rectangular tunnels) results in stresses in the transverse direction of the tunnel. Generally it is vertically propagating shear waves that govern the ovaling or racking stresses (Wang).

The objective of this study is to compare several different methods for evaluating seismic racking loads on a buried reinforced concrete tunnel. A well-known approach for design of new tunnel is that developed by Wang in the early 1990's. Based on the relative flexibility of the tunnel and surrounding soil media, an estimate of the structural racking deformation with respect to the free-field lateral soil displacement is made. A cross-section of the tunnel can then be evaluated under static loading conditions that cause the estimated racking deformation. In another method, Soil-Structure-Interaction (SSI) is performed on the buried tunnel using the computer code SASSI. Structure forces are obtained directly from the SASSI model. Finally, a very simplified approach is used that places the tunnel on a bed of soil springs. In all methods, the computer code SHAKE is used to determine soil column displacements.

A case study is presented for a buried tunnel structure at SRS. Results indicate the Wang approach produces very conservative results compared to the other methods. SASSI results are shown to be of the same order of magnitude as the simplified soil-spring approach.

References:

Wang, J. (1993). Seismic Design of Tunnels – A Simple State of the Art Design Approach. Parson Brinkerhoff Monograph 7.